8-31-2018

Protect Your Brain: The Impact of an Educational Intervention on Helmet Use in Adolescents

Daniella Mlinarevic
University of Windsor

PROTECT YOUR BRAIN: THE IMPACT OF AN EDUCATIONAL INTERVENTION ON HELMET USE IN ADOLESCENTS

By
Daniella Mlinarevic

A Thesis
Submitted to the Faculty of Graduate Studies
Through the Department of Biological Sciences
In Partial Fulfilment of the Requirements for
the Degree of Master of Science at the
University of Windsor

Windsor, Ontario, Canada

Protect Your Brain: The Impact of an Educational Intervention on Helmet Use in Adolescents

by

Daniella Mlinarevic

APPROVED BY:

S. Berg
Leddy Library

K. Poling
Department of Biological Sciences

L. Buchanan, Advisor
Department of Psychology

August 28th, 2018

Declaration of Originality

I hereby certify that I am the sole author of this thesis and that no part of this thesis has been published or submitted for publication.

I certify that, to the best of my knowledge, my thesis does not infringe upon anyone's copyright nor violate any proprietary rights and that any ideas, techniques, quotations, or any other material from the work of other people included in my thesis, published or otherwise, are fully acknowledged in accordance with the standard referencing practices. Furthermore, to the extent that I have included copyrighted material that surpasses the bounds of fair dealing within the meaning of the Canada Copyright Act, I certify that I have obtained a written permission from the copyright owner(s) to include such material(s) in my thesis and have included copies of such copyright clearances to my appendix.

I declare that this is a true copy of my thesis, including any final revisions, as approved by my thesis committee and the Graduate Studies office, and that this thesis has not been submitted for a higher degree to any other University or Institution.

Abstract

According to Statistics Canada (2016), approximately 70% of children aged 15-17 in Ontario reported cycling over the last year. It is the law in Ontario that any cyclist under 18 wear a helmet (Ministry of Transportation, 2016). Despite this regulation, less than half of teenagers in Ontario report always wearing their helmet when cycling (Statistics Canada, 2016). This is a clear cause for concern when considering the prominence of brain injury due to cycling-related accidents (Coronado et al., 2007; Burt & Overpeck, 2001). This project attempted to address this issue by analyzing whether an educational intervention based on the functions of the brain and its importance in our daily lives could increase helmet use in adolescents. It was predicted that participation in this project would lead to an increase in the perceived risk of cycling without a helmet, thus ultimately leading to an increase in helmet use. The results supported the hypothesis, with a main effect found between pre-test and post-test scores for helmet-related questions in all groups who participated in the project. These results were also different from those of a control group, who participated in a generic bike safety intervention. The results of this project show great promise in the effectiveness of this educational intervention on helmet use and thereby have major implications for the future of helmet safety in the community.

Acknowledgement

I would first and foremost like to thank my thesis advisor Dr. Lori Buchanan of the University of Windsor Psychology department. Her constant support and advice throughout this entire process was invaluable. The metaphorical door to her office was always open whenever I needed any assistance. She consistently allowed this paper to be my own work, but steered me in the right the direction whenever she thought I needed it. This entire project would have been impossible without her guidance and for that I am forever grateful.

I would also like to acknowledge Dr. Selinda Berg of Leddy Library and Dr. Kirsten Poling of the Department of Biology at the University of Windsor as my committee members, and I am incredibly grateful for their very valuable comments on this thesis.

In addition, I would like to thank my fellow lab members Vince, Brette, and Tara for their input and support throughout this entire process. Their helpful feedback, thoughtful suggestions, and assistance with statistical analyses ensured that this process was as smooth as possible and I could not have done this without their help.

Finally, I must express my very profound gratitude to my parents and friends for providing me with unfailing support and continuous encouragement throughout my years of study and through the process of researching and writing this thesis. This accomplishment would not have been possible without them. Thank you.

Daniella Mlinarevic

Table of Contents

Protect Your Brain: The Impact of an Educational Intervention on Helmet Use in Adolescents

Introduction

For most children and adolescents, cycling can be a reliable and enjoyable form of transportation. According to Statistics Canada (2016), approximately 80% of children in Ontario between the ages of 12-14 report having cycled at some point over a one-year period, and this number remains elevated for those aged 15-17, with approximately 70% reporting that they have ridden a bicycle over the last year. It is the law in Ontario that any individual under 18 must be wearing a helmet when cycling (Ministry of Transportation, 2016). In fact, this is the law in almost all provinces in Canada, with the exception of Saskatchewan and Quebec (Canadian Paediatric Society, 2017). Despite this, statistics suggest that only 42% in the 12-14 age group and a remarkable 28% in the 15-17 age group report always wearing their helmet when cycling (Statistics Canada, 2016). Therefore, it is likely that well over half of the adolescents in Canada are wearing their bike helmets infrequently, if at all. With the prevalence of cycling related injury (Burt & Overpeck, 2001; Kelly et al., 2001), this is a clear cause for concern. Finding a solution that will encourage adolescents to participate in more safety-related behaviours while cycling (i.e., wearing a helmet) is essential to decrease preventable head-related injuries.

The necessity of helmets when cycling has been consistently shown through research. For example, the American Association for Neurological Sciences (2014) has demonstrated that cycling is the number one cause of head-related injury in children under the age of fourteen, placing it well above other high contact sports such as football and hockey. Although helmet-safety in football has received frequent media attention recently, there is relatively little discussion on helmet use in cycling. However, traumatic brain injuries (TBIs) are the leading cause of death among cyclists, accounting for three quarters of deaths associated with cycling

(Coronado et al., 2007). While many still argue that a helmet does little to protect in cases of bicycle accidents (Hooper & Spicer, 2012), or that use of a bicycle helmet can actually increase risk-taking behaviour (Gamble & Walker, 2016), most research supports the notion that bicycle helmets, at the very least, offer some protection to the wearer. For example, Maimaris and colleagues (1994) collected data from individuals in a local hospital who were admitted for a bicycle-related injury. Of the approximately 1000 individuals in the study, only 114 had been wearing a helmet at the time of the accident. The researchers concluded that helmets were effective at protecting the head because only 4% of helmet-wearers were admitted for a head-related injury, compared to the 11% of non-helmet wearers (Maimaris, Summer, Browning, & Palmer, 1994). Interestingly, Thomas and colleagues (1994) discovered similar findings in a group of children and adolescents. Their study focused more specifically on injuries acquired on areas of the head that would have been normally covered by a helmet (i.e., the top of the head and the upper face). They found that through use of a helmet, the risk of head-related injury was reduced by 63% (Thomas et al., 1994). This has been further supported through investigations on whether injury was decreased in cases with helmet use; for all non-motor vehicle crashes, amongst all age groups studied, there was a decrease in head-related injury probability when a helmet was worn by the rider (Povey, Frith, & Graham, 1999).

Unfortunately, the belief that helmets provide little protection in cases of accidents is widely accepted. Many people, especially adolescents, believe that they are not at an increased risk for injury without a helmet and that helmets are unnecessary. This misperception leads to simple justifications for riding without helmets. For example, Finnoff, Laskowski, Altman and Diehl (2001) surveyed adolescents between the ages of 11-19, and found that the number one reason for choosing not to wear a helmet was the fact that it was considered “annoying”.

Additionally, 22% of the respondents reported not wearing a helmet because it would “mess up their hair”. Another commonly listed reason was simply not owning a helmet at all (Finnoff et al., 2001). A separate study showed that individuals could be positively influenced towards helmet use if those around them, including parents and friends, were also wearing a helmet (Secginli, Cosansu, & Nahcivan, 2014). Parental influence can also directly impact an individual’s helmet use, but this influence has been shown to taper off around age 12 (Berg & Westerling, 2001; Miller, Binns, & Christoffel, 1996). These findings demonstrate that there is a social aspect that contributes to the misperception that helmets are not essential to wear, and thus, leads to non-compliance of helmet-wearing.

A likely contributor to these arguments against helmet use posed by adolescents is the lack of awareness about the importance of a helmet and an understanding of the risk involved when riding unprotected. The limited value placed on safety in comparison to things such as appearance or annoyance is likely a result of the lack of information provided to those wearing helmets. Witte and colleagues (1993) assessed how the perception of a potential bicycle-related injury influences helmet-wearing behaviour. They found that individuals who believe the potential threat of injury to be higher are more likely to participate in safety and helmet-related behaviour (Witte, Stokols, Ituarte, & Schneider, 1993). Quinne, Rutter, and Arnold (2001) suggested that in order to increase the use of helmets in school-age individuals, it is necessary to change their beliefs regarding helmet use and safety practices.

The Health Belief Model (HBM) describes a decision-making model an individual subconsciously uses when choosing to participate in any behaviour related to their health (Rosenstock, 1974). This model is based on five positive or negative factors associated with the behaviour, including the perceived barriers, or cost, of performing the behaviour, the perceived benefit, one's susceptibility to the consequence of not performing the behaviour, the perceived severity of said consequences, and potential cues to encourage the action of the behaviour (Rosenstock, 1974). To put it in terms more relevant to this study, it could be phrased as: 1. the perceived cost of wearing a helmet (e.g., annoying, it could ruin your hair, it costs money to purchase a helmet); 2. the perceived benefit of wearing a helmet (i.e., the protection that it would offer from injury); 3. how susceptible one would be to an injury related to not wearing a helmet (i.e., how likely is it that one could fall off their bike and injure their head due to a lack of helmet use); 4. the perceived severity of falling off (e.g., life-altering or minor); 5. a cue for one to actually use their helmet, such as an in-class presentation or seeing someone else wearing their helmet. After a mental calculation, an individual would weigh the result of each of the five factors against each other to determine conclusively whether or not they should participate in the behaviour; in this case, wearing a helmet versus going without one.

Presumably, the only way to change any weight in any of those categories externally is to introduce a new cue to action. In this case, potential cues could be introducing a new educational intervention related to cycling that could increase one's perceived susceptibility to a brain-related injury (i.e., TBI) as a result of a cycling incident, increase one's perceived level of severity of a head-related cycling injury, and/or subsequently increase their perceived benefit of using a helmet. Often, perceived severity and perceived susceptibility can be thought of in unity as "perceived threat" (Rosenstock, 1974). Witte and colleagues (1993) addressed this model in relation to helmet use during cycling and found that by using cues to action such as communitywide events and physician counselling, there was an increase in the perceived threat of cycling. As previously mentioned, this perceived threat also indicated a higher likelihood of participating in helmet-related safety behaviours, such as purchasing a helmet for one's child, encouraging a child or adolescent to wear the helmet, or wearing a helmet altogether (Witte, Stokols, Ituarte, & Schneider, 1993). Research using measures related to the HBM has also shown that an observed influence in cues to action plays a role in helmet use in skateboarders (Peachey, Sutton, Cathorall, 2016), and cyclists (Ross et al., 2010).

Another relevant model is the Theory of Planned Behaviour (TPB; Ajzen, 1985). Born from the Theory of Reasoned Action (Fishbein and Ajzen, 1975), this theory creates a link between one's beliefs and their behaviour. It relies on the assumption that behaviour is mediated by a behavioural intention, and this intention is determined by three factors: an individual's attitude towards the behaviour, the subjective norm, and the perceived behavioural control the individual has (Ajzen, 1985; Quine, Rutter, & Arnold, 1998). The first factor is the product of one's consideration of the positive and negative aspects of performing the desired behaviour (Quine, Rutter, & Arnold, 1998). Attitude thus accounts for both an evaluation of the possible outcomes as well as believed probability that each possible outcome could occur. Subjective norm is a balance of the expectations from others related to how willing one is to comply with these expectations. Lastly, an individual's perceived behavioural control describes how much control the individual believes they have over the behaviour in question (Quine, Rutter, & Arnold, 1998). Unlike the Health Belief Model, the TPB predicts behaviour probability through intentions (Quine, Rutter & Arnold, 1998).

Using these models as a method of developing an educational intervention that could potentially influence one's behaviour may encourage helmet use. While the Health Belief Model has its merits, the TPB may be best suited for the purposes of this study for a few reasons. Arnold and Quine (1994) found that the HBM could account for 53% of the variance found in helmet use. However, more recent studies which compare the ability of the HBM and TPB to account for the variance in helmet use show that the TPB is actually better suited to determine these variances (Quine, Rutter, & Arnold, 1998). Lajunen and Räsänen (2004) suggested that the use of the TPB when examining bicycle helmet use and intentions was more effective than that of the Health Belief Model. This means that in order to influence an individual's helmet use and increase their intention of using one, the most effective approach is to target their attitudes towards the behaviour in order to lead to an increase in this behaviour. Additionally, the TPB may be best to account for any potential social influence as a result of this project. It can be reasonably concluded that if every student in the classroom is participating in the same intervention, there may be some sort of horizontal influence amongst peers that was not initially present. The present study will most directly attempt to change attitudes of the participants towards helmet use through the introduction of increased potential risk as a possibility of riding without a helmet.

Many attempts have been made to address the issue of helmet use and potentially increase its prevalence amongst children and adolescents. Most of these, however, focus on presenting general bicycle and safety information through in-class presentations, communitywide events, or using other means (Moore & Adair, 1990; Towner & Marvel, 1992; Goldenbeld, Boele, & Commandeur, 2016). Many countries, including most of Canada, have even begun to mandate helmet use as a part of the law, which has met some success (Rodgers, 2002; MacPhearson & Spinks, 2008; Coté et al, 1992; LeBlanc, Beattie, & Culligan, 2002). However, as reported by Pendergrast and colleagues (1993), even the most intensive safety education and training leads to limited success in terms of increased helmet use. Although there has been a positive impact reported due to mandating helmet use (Carpenter & Warman, 2018; Rodgers, 2002), that impact has somewhat subsided and half of the adolescents in Canada continue to report never wearing a helmet (Huybers et al., 2017; Statistics Canada, 2016). Many individuals have reported that not abiding by the law is partially due to the fact that they believe helmet use will not be as strictly enforced as other laws (Finch, 1996).

Unfortunately, very few of the interventions used actually address the importance of a helmet beyond general statements about protection and safety, including statements such as "it protects your head" or "it'll stop you from getting hurt". Presumably, most adolescent students have little information on *why* they should be protecting their heads. That is, most adolescents have limited, if any, exposure to neuroscience-related education, and thus have no knowledge on the functioning of the brain and its crucial impact in executing our everyday behaviours. As such, adolescents could be underestimating the importance of protecting their brain from a preventable acquired brain injury.

Recent research done by Barnes, Maria, Hopkins and Caldwell (2012) supports the belief that an educational intervention that involves basic neurological information could be beneficial in increasing helmet use. Their study used an educational intervention specifically designed to educate children on the dangers of not wearing a helmet and the impact that a brain injury could have on one's life. They studied children who were in the local hospital, although it was not necessary that the participants were in the hospital for a cycling-related injury; all the participants indicated in a demographic survey that they regularly rode their bikes (Barnes, Maria, Hopkins, & Caldwell, 2012). The researchers used a pre-test/post-test technique to measure differences in safety perception and subsequent helmet use before and after a five-point intervention regarding brain injury prevention and helmet use. This included discussion of the various functions of the brain, basic brain anatomy, a demonstration of the delicacy of the brain through the use of an unprotected egg, a second brain demonstration using a gelatin mold, and a simulation of how life would be with a brain injury. The control group in the study received a bicycle helmet and safety brochure but no educational intervention. It was found that 96% of the individuals in the experimental group reported always wearing a helmet at three month follow up, in comparison to the 80% helmet use rate in the control group (Barnes, Maria, Hopkins, & Caldwell, 2012). This research was influential as it introduced the importance of stimulating children's and adolescent's understanding of *why* they should wear a helmet. Moreover, the researchers demonstrated that an educational intervention geared towards the importance of the brain and its functions to our daily lives could have a positive impact on the participants' perception of safety and their frequency of helmet use. However, this study mainly used children as participants, and limited research has been done with adolescents, who reportedly use their helmets the least (Statistics Canada, 2016).

With the complexity of an organ such as the brain, it can be challenging to ensure that an adolescent fully understands the functions and each of their implications in our lives. Thus, it is important to assess the individual's understanding of this content and ensure that they do have some level of comprehension prior to examining the influence this content has on their lives and their outlook on safety. If students' safety perceptions were tested directly after a presentation of content, it is impossible to know what influence the presented material really had on their perceptions and to what degree this material resonated with the student. Many teachers employ various tactics such as visual aids and hands-on experience in order to further develop the individual's understanding of the content beyond simple memorization. A visual aid could include photos, movies, or demonstrations used in conjunction with the presented information. A hands-on experience would provide the individual with the opportunity to directly apply their newfound knowledge to a project in front of them to offer a deeper comprehension. Deep processing is often achieved through semantic processing or elaboration, which is where an individual processes the information based on its meaning and its relationship to other meaningful information (Hirshman, 2001; Craik & Lockhart, 1972). This allows them to integrate this information with pre-existing knowledge, which ultimately allows them to understand it and remember it better than if they were simply asked to read it themselves (Craik & Lockhart, 1972; Craik & Tulving, 1975). If one is attempting to educate a young student on the functions of the brain, for example, it would be important to allow them the opportunity for deeper processing through the use of a hands-on project and other learning aids in order to ensure they retain the necessary information.

One primary avenue that this can be achieved in a classroom setting is through the use of art. Art projects allow the students to express themselves and certain subjects in ways that make sense to them, meaning that they are applying their own understanding of the information to the project through this elaboration (Hirshman, 2001). This also allows them the opportunity to create a visual aid for the learned information, meaning that the result of an art project based on a certain topic should ultimately be the deeper understanding of the presented material by the student. In addition, being given the creative freedom to relate the material directly to themselves and their lives allows for higher-level elaboration through the self-reference effect (Klein & Kilstrom, 1986).

As mentioned, it is possible that the most effective approach is to target an individual's attitude towards a certain behaviour in order to get them to participate in this behaviour. A possible method is the use of an educational intervention that focuses on *why* the individual should care about protecting their brains. This would hopefully increase not only the perceived threat but also the perceived benefit of regularly using a helmet. Previous research done on this topic (Mlinarevic, unpublished) found promising results using a method similar to the one proposed for this project. However, those results should be interpreted with caution as they have low statistical power. In addition, that study used a questionnaire more specifically targeted to a younger audience, which may have influenced the students' responses. Finally, that study was conducted over a shorter period of time, which may not have given the students the opportunity to fully process all the information they had learned and thus may not have had as much lasting power. The present study will act as a sequel to the foundational study, with an improved questionnaire, a larger sample size, and a larger time period of study in order to hopefully solidify the results and establish a new method of approaching the issue of helmet safety when cycling.

Raising awareness about the brain's role in our daily lives, the importance of protecting our brain, and the potential consequences of acquired brain injury are key to a successful intervention to encourage helmet use among adolescents. Research has highlighted how helmet use consistently reduces the risk of head-related injury when cycling (Thomas et al., 1994; Maimaris, Summer, Browning & Palmer, 1994). Considering the brain's role in our everyday functioning, it is important that we increase the use of helmets for a safer and more responsible community. The next step is to design an intervention that educates adolescents to encourage consistent helmet use and increase their willingness to wear one, as previous research was targeted towards children. The present study aimed to improve the perception of helmet safety in adolescents through an assessment of cycling-related health and safety perceptions both before and after the completion of an educational intervention and subsequent art project regarding the functions of the brain. The goal is to ultimately increase helmet use by altering their safety perceptions. This was compared to a group of adolescents who receive a standard helmet safety intervention that does not emphasize the functions of the brain. It was predicted that following this intervention, the attitude towards helmet use of the adolescent participants receiving the educational intervention would change positively due to an increase in the perceived risk and that they would ultimately indicate a higher likelihood of helmet use when cycling. While previous results were promising, the present study aimed to confirm that targeting the students' attitudes towards helmet use by presenting them with new information is the best path to take to increase helmet use. Through the use of an educational intervention, it was the hope that these students learn the importance of the brain to our daily lives and use this information to make an informed decision about helmet use and future safety precautions.

Methods

Participants

There were 108 participants in this study, with ages ranging from 14-17 years old. Participants were recruited from two local high schools. They were students in the visual arts courses at their respective schools during either their first or second semester of study in their academic school year. Any student who indicated they did not own a bike would not be included in the data analysis. Compensation included a chance to win movie tickets from a draw.

Materials

Questionnaires. Each participant initially received a paper copy of a demographic questionnaire asking their age, gender, how frequently they ride a bicycle, and how often they wore a helmet when they ride. The participants were instructed to record their responses by circling the most appropriate option using a pen or pencil.

The participants were also provided with two separate questionnaires, one before and one after the art project. The pre-test questionnaire consisted of 52 items, and the post-test questionnaire consisted of 44 items. Both questionnaires (Appendix A) drew items from a combination of eight different measures and utilized a five-point Likert scale. The eight measures used include the BACKIE questionnaire, designed by Morrongiello and colleagues (2008), the Fear of Crime Scale (Boateng, 2016), the Health Survey (Janssen, 2014), the Social Network Scales (Cole et al., 2017), the Moral Identity Questionnaire (Black & Reynolds, 2016), the Perceived Risk of Traffic Situations Scale (Beck & Watters, 2016), the Effort-Reward Imbalance Questionnaire (Wege et al., 2017), and the Perceptions of the Environment in the Neighborhood Scale (Adams et al., 2013). The questionnaires for this study were designed to act as "Student Life" questionnaires, with some key cycling and safety-related questions throughout both surveys. While the majority of the questions were intended to be used as filler questions or for additional analyses, there were three questions in both the pre-test and the post-test questionnaire that were specifically intended to assess helmet use and safety perceptions towards helmets: "I always wear a helmet when I ride my bike" (Janssen, 2014); "I don't think I will be badly hurt if I fall off my bike" (Morrongiello et al., 2010); and "As you get older, you do not have to worry so much about wearing a bike helmet when you ride your bike" (Morrongiello et al., 2010). The remainder of the questions were either health and safety-related or simply filler questions. The questionnaires were all identified with a number in order to protect the confidentiality of the participant. The questionnaires were collected by the researcher and securely stored.

Helmet Project. The classrooms were given 110 helmets (55 each) provided by the brand Nutcase™. Each participant worked individually to complete his/her own helmet. For the art project, the students needed paint, a gesso primer, pencils, markers, paint brushes, and any other necessary art materials. This project was to be completed during class time.

In-Class Presentations. All groups received a presentation on either road visibility and helmet safety (control group) or the functions of the brain (experimental group). Each presentation was approximately 15 minutes long and was given by the researcher.

Procedure

This research project received approval from the University of Windsor Research Ethics Board, the Greater Essex County District School Board, and the Windsor Essex Catholic District School Board. This study used both a within-subjects and a between-subjects approach. The participants can be classified in three groups: a control group of mean age 14, an experimental group of mean age 14, and an experimental group of mean age 16. This was done to allow for comparisons between age in terms of effectiveness of the intervention. The participants of one school acted as the 14-year old control group and the 16-year old experimental group, and the participants of the second school were all included in the 14-year old experimental group. The first steps of the procedure were identical for both groups. They were first given approximately one week to get consent forms signed by their parent/guardian. After one week, both classes were given the demographic questionnaire and initial pre-test questionnaire to assess their health and safety perceptions. This was done using a printed copy of the questionnaire and a pen or pencil. The questionnaires were numbered with participant IDs, and a list of the students and their corresponding IDs was created and kept by the teacher for the duration of the study. This list was destroyed upon completion of the study and was only necessary in order to ensure that the integrity of the pre-test/post-test design is maintained. Three weeks after the initial questionnaires are collected, the researcher provided the participants with an educational intervention. The remaining procedure for each group will be outlined separately below.

Control Group. For the control group, the educational intervention involved a presentation on basic bike and helmet safety, including visibility and rules of the road. This presentation was approximately fifteen minutes and mimicked those normally given to participants during the school year, including information such as how to properly secure a helmet, how to use hand signals when cycling, and how to maintain visibility at all times as a cyclist. All of the information in the presentation was made available to the participants electronically. Once the presentation was complete, each student was then given a Nutcase bicycle helmet. The participants were instructed to design the helmet in any way they would like, as the helmets would be donated to local children and adolescents who do not have the means to purchase a helmet of their own. The students were encouraged to maintain their creativity throughout the project and progress was monitored by the classroom teacher. The students had approximately one month to complete these helmets during class time. Approximately two weeks after the completion of the helmets (seven weeks from the initial questionnaire administration), the researcher once again returned to the classroom for the administration of the post-test questionnaire. The participants were given the same participant ID as they had received at the beginning of the project. Once all the questionnaires were completed, they were collected by the researcher and stored in a secure location.

Experimental Group. The experimental group received a fifteen-minute presentation on the functions of the brain, including demonstrations of how certain functions are controlled by certain areas of the brain. For example, the researcher would describe that vision is primarily controlled by the back of the brain and that damage to this area could result in visual impairment.

The classroom teacher made the information from the presentations available to the students electronically. Once the presentation was complete, the researcher then provided each participant with a Nutcase helmet and instructed the students on their task. Unlike the control group, the participants in the experimental group were asked to apply the information they learned in the presentation to their helmet design. These participants were asked to depict the various functions of the brain onto the helmet; for example, including some depiction of eyes or vision on the back of the helmet, as vision is controlled by the occipital lobe. These participants were told that the helmets would be given to various bike stores and organizations within the community to be used as educational tools for the promotion of helmet use. The design and painting of the helmets took the students approximately one month to complete. Approximately two weeks after the completion of the helmets, the participants were asked to complete the post-test questionnaire, with the same participant ID as the one used in the beginning of the project. Once the questionnaires were completed, they were collected by the researcher and stored in a secure location. The procedures for both the younger experimental group and the older experimental group were identical.

Results

There were 108 participants in this study. Nine were excluded from data analysis for lack of signed consent forms or invalid data, and the remaining 99 were used. Ages ranged from 14-17. The overall group consisted of approximately 45% males and 55% females. A full demographic summary can be seen in Table 1. Upon initial completion of the demographic questionnaire, all students indicated that they owned or had access to a bicycle.

Table 1
Participant demographic information.

Group	Number of Participants	Mean age (years)	% Males: % Females	% Reported Low Helmet Use
Control Group	22	14.2	50 : 50	73
Experimental Group 1	24	14.2	54 : 46	75
Experimental Group 2	25	14.2	50 : 50	32
Experimental Group 3	28	16	29 : 71	79

There were three direct questions included in the questionnaires addressing perceptions of safety with regard to helmet use, such as: “I always wear my helmet when I ride my bike”; “as you get older, you do not have to worry so much about wearing a helmet when you ride your bike”; and “I do not think I will be badly hurt if I fall off my bike”. The questions were all coded so that a higher score indicated a higher perception of safety. The mean was then found for these three questions for each participant on both the pre-test and post-test questionnaires, in both the experimental and control conditions. The dependent variable was the difference in the score of helmet perception before and after the completion of the intervention, and the independent variable was the group to which the participant was assigned. First, paired samples t-tests were completed to directly compare the means of the pre-test scores to the post-test scores within each group. The results showed that students in all experimental groups showed a significant difference between their pre-test and post-test scores, while the control group did not (Table 2). While it should be noted that the pre-test helmet scores of experimental group 1 were significantly lower than the other classes, this study aimed to examine only the *change* induced by the educational intervention, rather than the starting point of their helmet safety perceptions.

However, for this reason, the two 14 year old experimental groups were analyzed separately rather than combined into one experimental group.

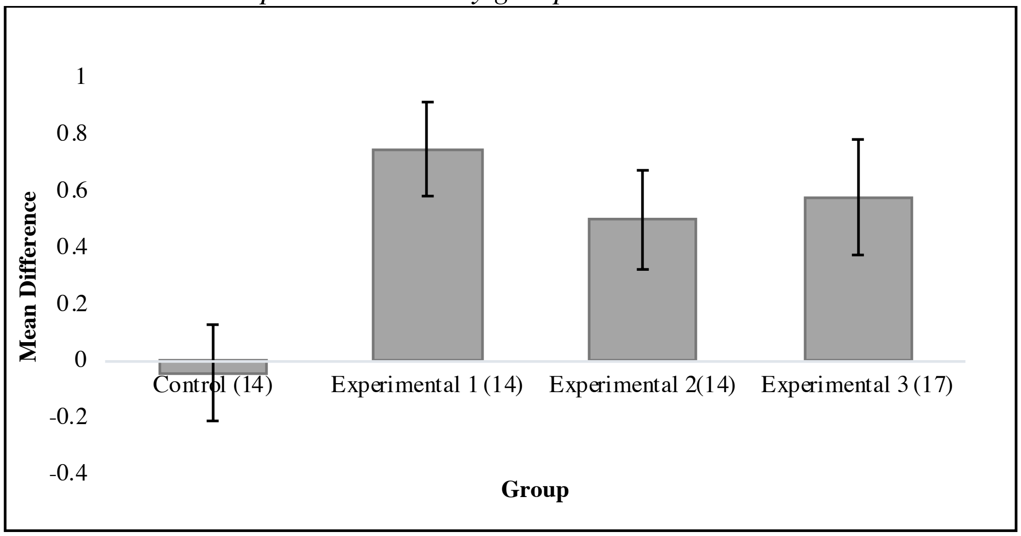
Table 2

Results of paired-samples t-tests for pre-test and post-test scores within each group.

Group	Pre-test mean score	Post-test mean score	t-test results
Control (14)	2.93	2.89	$t(21) = 0.267$, $p > 0.05$
Experimental 1 (14)	2.49	3.24	$t(23) = -4.525$, $p < 0.05$
Experimental 2 (14)	3.01	3.51	$t(24) = -2.812$, $p < 0.05$
Experimental 3 (17)	2.73	3.31	$t(27) = -2.859$, $p < 0.05$

The effects of intervention (experimental group 1 vs. experimental group 2 vs. experimental group 3 vs. control group) on helmet safety perception (difference in means between post-test vs. pre-test scores) were analyzed with a one-way analysis of variance (ANOVA) (Figure 1). While some of the data violate the assumption of normality, the ANOVA has been shown to remain robust even with non-normal distributions (Norman, 2010). However, homogeneity of the variances in each of the groups was shown ($p > 0.05$), thus complying with the assumptions of an ANOVA. There was a main effect of helmet safety perception, $F\ (3, 95) = 3.26$, $p < 0.05$. There were no significant differences found within the responses on the other elements of the questionnaire. Additionally, there was no correlation found between the helmet-related questions and other questions on this questionnaire ($p > 0.05$ for all correlations). This included examination of items associated with neighbourhood safety, morality, effort/reward, driving risk, helmet perception, general safety behaviour, and social media use. There was a small correlation between driving risk perception and helmet perception ($r = 0.24$, $p > 0.05$), although due to the small Pearson's correlation coefficient, this should be interpreted with caution.

Figure 1
Difference in Post-test and pre-test scores by group.



Pairwise t-tests were used to compare the differences of the means of each 14 year old experimental group to the 14 year old control group. The results for these comparisons indicated that the difference between post- and pre-test scores was significantly higher in the experimental 1 group than the control [$t(44) = -3.3472$, $p < 0.05$]. This effect was also seen in a comparison of the experimental 2 group and the control [$t(45) = -2.2035$, $p < 0.05$]. The older experimental group and the control group's mean scores were also compared, and this effect was maintained [$t(48) = -2.2800$, $p < 0.05$]. However, as there is a difference in age, these results should be interpreted with caution.

Finally, pairwise t-tests were completed between all the experimental groups to determine if there was any effect of age on the outcome of the questionnaires. There was no observed difference between experimental groups 1 & 2 (both of the same age) [$t(47) = 1.0634$, $p > 0.05$], experimental groups 1 & 3 (14 year old group vs. 17 year old group) [$t(49) = -0.634$, $p > 0.05$], or experimental groups 2 & 3 (14 year old group vs. 17 year old group) [$t(50) = 0.33445$, $p > 0.05$].

Discussion

The results of this study support our hypothesis that an educational intervention on the functions of the brain lead to a higher perception of bicycle helmet safety. The post-test scores on helmet-related questions in all three experimental groups showed a higher perception of helmet safety when compared to the control group. The control group, who completed a standard helmet and bike safety intervention, showed no increase in their scores post-intervention. There was no difference among the three experimental groups, indicating that age did not have an impact on the effectiveness of the program. This observed change in helmet safety perception implies that an educational intervention based on the functions of the brain and its importance in our everyday lives has a positive impact on students' perceptions of the importance of helmets to our safety. Additionally, it also demonstrates how much more successful this approach is when compared to a traditional bike safety presentation. The fact that there was no increase for any of the other questions, including questions related to other aspects of health and safety behaviour and perceptions (such as those related to driving risk and neighbourhood safety) indicates that the effect exhibited in this study is limited only to cycling-specific perceptions and behaviours. Nonetheless, these findings are extremely promising for the future of helmet safety and have major implications with regards to helmet use in our community.

These results are consistent with previous findings in the field. Primarily, it confirms previous results obtained using a similar method (Mlinarevic, unpublished). With the increased sample size, consistency between all of the groups, and adjustments to the administered questionnaire, the results still support the original hypothesis that this educational intervention would positively impact the students' perception of safety with regards to helmets. Similarly, it also supports the findings of Barnes and colleagues (2012), which suggested that educating younger individuals on the functions of the brain and increasing their awareness of its importance led to an increased likelihood of these individuals wearing a helmet. As reported by Witte, Stokols, Ituarte, and Schneider (1993), an increase in the perceived threat to one's safety could ultimately lead to an increase in the individual's willingness to partake in some safety behaviour (in this case, wearing a helmet), and it seems that the intervention used did just that by demonstrating to students how important the brain is to our lives. Future research could alter the intervention by including elements from the Barnes (2012) study (such as the demonstrations of the fragility of the brain) to further impact their perceived threat directly.

Further, the Health Belief Model (Rosenstock, 1974) argues that an individual makes a series of mental calculations based on the perceived weight of the potential consequences in comparison to the potential benefit of participating in a certain health behaviour. The mental calculation can be influenced by a cue to action, which could act to change the perceived weight of one of the categories of the model. In this case, the cue to action is the educational intervention provided to the students. The experimental intervention acted to increase the perceived threat, which is the combination of the perceived possibility of injury with the perceived severity of said injury (Rosenstock, 1974). The HBM has also been shown to support predictions of bicycle helmet use (Ross et al., 2010). Furthermore, the influence of an increase in the perceived threat – a component of the HBM – has been shown to be a positive predictor of helmet use (Witte, Stokols, Ituarte, Schneider, 1993). During the initial presentation of information, there was discussion of possible consequences of various forms of head injury which may have resonated with the students and would thereby act to increase the perceived threat of cycling without a helmet, thus changing its weight during consideration of the behaviour. If the perceived threat were increased enough, this could be the deciding factor which causes the student to choose to wear a helmet when they would normally ride without one.

Similar to the Health Belief Model, the Theory of Planned Behaviour also assesses potential influences on an individual's health-related behaviour (Azjen, 1985). However, this model may be more suitable for this particular project, as it suggests that behaviour is modulated by an intention to perform a particular behaviour. Behavioural intention is influenced by three factors: attitude towards the behaviour, the subjective norm of this behaviour, and perceived behavioural control (Azjen, 1985). First and foremost, the intervention primarily targeted the attitudes of the participants in an attempt to change their attitude toward helmet use. According to Azjen (1985), the attitude component accounts not only for an evaluation of the possible outcomes, but the perceived probability of each outcome occurring. The intervention was designed to influence both of these components – initially to introduce a brain injury as a potential outcome, and subsequently to increase the perceived probability of its occurrence when cycling.

However, other side effects from this intervention could have also had a positive impact on the eventual behavioural intention. For example, a second component of the TPB is the subjective norm of a certain behaviour, which essentially describes the expectations that others have for one to perform the behaviour, and how willing the individual is to comply with these expectations. Since all of the students in the classroom received the same information on the functions of the brain, it is very likely that there could be some peer influence on a participant's eventual decision to wear a helmet, which would be an introduction of a new expectation on the participants, even if their attitudes weren't particularly affected. For example, if three students all begin to wear their helmets more often as a result of the project itself, a fourth student might be inclined to wear their helmet because of their newly introduced social influence (Cialdini & Goldstein, 2004). While this was not the main intention of this project, this horizontal byproduct would only be providing further evidence for the influence this project may have on its participants. In fact, Lajunen and Räsänen (2004) suggest that this social influence is quite influential, and that one of the most effective ways to increase helmet use is to "influence peer opinion", as per the TPB. The participants on the experimental project could even act as ambassadors for bike safety. Through various social interactions, it is possible that they would increase helmet use in others by explaining to them what they had learned from the educational intervention and cause a chain reaction of increased helmet use amongst their peers. Future research should explore these hypotheses by including measures of susceptibility to social influence and willingness to comply with others in the pre-test and post-test questionnaires. While parental influence has also been shown to have an effect on helmet use in children and adolescents (Berg & Westerling, 2001; Miller, Binns, & Christoffel, 1996), for the purposes of this study, it was assumed that this influence remained constant throughout the project and thus had no impact on the results of the experiment.

Figure 2.
Examples of brain function helmets as painted by participants.

While the findings of this experiment indicate a positive outcome from the educational intervention, there are a few factors that should be considered when examining the results. One major limiting factor on this study was the organization of the groups into experimental and control. Ideally, each group would receive a different designation than the other classes involved in the project; this decision ultimately depended on how the classroom teacher was willing to divide their classes. For example, both 14 year old experimental groups came from the same school with the same teacher. The most ideal division would be one group acting as the control and one as the experimental, but the teacher requested that both her classes participated in the same project in order to maintain consistency with her lesson plans. In addition, because of the social nature of the students and their high level of interaction outside the class, it would have been challenging to limit discussion between the groups if they were working on different projects. A similar issue arose when attempting to match groups based on age. A control group of age 16 would have assisted in the analysis of the older group's results; however, only one school was willing to integrate the project into a higher grade level class. Although previous research (Mlinarevic, unpublished) did not suggest any significant difference in responses between an older control group's pre-test and post-test mean helmet scores, it would have improved the validity of the results of this project to have an older control group to compare with the experimental. For this reason, the results describing the differences between the control group and the 16 year old experimental group should be interpreted with caution as the different ages should also be considered.

In addition, there was a clear variance in starting points of helmet use (Table 1). While three of the groups indicated a very high rate of low helmet use (by a helmet use rating of "never" or "I don't own a helmet"), Experimental group 2 showed an impressively high rate of helmet use, with only 32% of respondents reporting never using a helmet. While the difference in the group's pre-test and post-test scores was still positive, this variance is still quite unusual. A potential explanation for this could be simply how high school classes are scheduled. Because of the limited course offerings (i.e. academic- vs. applied-level courses), most highly-achieving students will end up with similar schedules. While this may not necessarily be the case, it is possible that the organization of the students into each period may have sorted particular personality types into the same class period for the project. This variance should be explored and controlled for in the future by the inclusion of more participants from a more variant population to avoid any potential confound due to class schedule.

Another important consideration is the fact that most of the data collection for this project was done, unavoidably, during the cooler months of the year. Due to this, it is likely that a majority of the participants may not have ridden their bicycle throughout the duration of the study, which may have resulted in more hypothetical responses as opposed to responses that directly reflected their cycling activity (i.e. when asked to report how often they ride their bicycles or how often they use a helmet when they ride). If true, the material would have subsequently become less relevant to the student at the time, and could have influenced their responses. Studies that build upon these results could consider conducting the project with students enrolled in summer school, or students who live in an area which harbors proper cycling conditions year-round, allowing for the students to answer based on more recent personal experience rather than on hypothetical situations.

Perhaps one of the most interesting aspects of this experiment is the design of the interventions themselves. The control intervention was a typical helmet and bike safety presentation with a very clear intention: increased safety when cycling. However, the educational intervention on the functions of the brain never once mentioned cycling, aside from the general description in the consent forms. Primarily, it should be noted that the standard bike safety intervention had no perceived impact whatsoever on the participants. Additionally, the fact that the students made the connection between the information from the educational intervention and its real life applications is a testament to the influence this particular presentation had on the students. One key factor to consider is the fact that the canvas the students were using for their art projects was actually a bicycle helmet, likely inducing a priming effect and allowing the students to connect the concepts learned during the lecture to their real lives. Priming is the process of increased activation of a certain idea due to previous exposure to a related concept (de Wit & Kinoshita, 2015). Thus, the involvement of the helmets likely caused the students to associate the two ideas more readily and may have led to their consideration of brain function when responding to questions regarding helmet safety. This effect was likely not observed in the control group as the presentation they received directly referenced helmet use and safety, thus eliminating any potential implicit influence the canvas may have had. By the time the students began the art project with the helmets, any additional information drawn from the helmets would have been redundant. A probable way to examine the exact level of influence the helmets had would be to change the medium to something less suggestive, such as paper or a fabric canvas. Changing the medium would also allow the project to be offered to a much larger sample of students, as helmet availability and cost was a major limiting factor in the number of participants recruited.

The use of the art project in general provided some insight with regard to what information was resonating the most with the students. While not included as part of the analysis for this project, it was observed that many similar concepts appeared within the helmet design, including depictions of eyes, ears, hands (to represent somatosensation), and words (to represent language). These recurring concepts suggest that these concepts were the most readily understood by the participants, although additional research projects could perform a qualitative analysis of these recurring themes to identify which portions of the intervention attracted the students the most. Interpreting the students' artwork in this way could provide information on how to adjust the presentation to tailor it more directly to the students' interests. In addition, regardless of what the end product of the art project actually looked like, many students reported to both the teacher and the researcher a very developed understanding of various neurological functions and how they would be represented in the brain.

While it is likely that the art project itself contributed largely to the students' comprehension of the presented information, the use of art students specifically may make the results of this study less generalizable to other adolescents. It is also possible that students who share similar interests, such as an artistic interest, may share other personality types that may not be as prevalent in students of science or literature, for example. This potential confound could be eliminated by creating alternative forms of the "art project" that follows the educational intervention, which could include asking the students to complete a fill-in-the-blanks on the functions of the brain, ask the students to write a summary on the information presented, or even designing an in-class project where the students take the presented information and format it for presentation to a kindergarten class. The students could even be asked to perform a theatrical demonstration of the information learned. There are many ways to promote elaborative processing within adolescents, and each variation should ultimately lead to similar results as those found in the present study.

The results of this project could have huge implications for the future of helmet safety within the community. Insight into what could influence an increase in the perceived threat associated with cycling could ultimately lead to the development of regular in-class programs to promote helmet use. Being able to explain to students *why* their brains are important and why they should be protected is evidently crucial to the students' understanding of the risk involved in riding without a helmet. Hopefully this could lead to an increase in helmet use and, by default, a reduction in the risk of potential cycling-related traumatic brain injuries (TBIs) in adolescents in the community (Maimaris, Summer, Browning, & Palmer, 1994; Thomas et al., 1994). Future research should examine the lasting effects of this project with a third administration of the survey after a 6-month or year-long time period. Finally, more in-depth analyses should also be completed with the development of a questionnaire more suited to the content of this project. This would include the addition of more questions directly related to cycling safety perception and behaviour, as well as questions to assess how much information from the presentation the students seemed to understand. Additionally, there could be certain measures used to allow the researchers to determine how much of the change was due to the presentation and its influence on their attitude, and how much was due to other influences such as those from the subjective norm or perceived behavioural control.

Overall, the results of this study support the hypothesis that an educational intervention regarding the functions of the brain increases the perception of bicycle safety in adolescents, indicating a potentially higher likelihood of helmet use. The findings of this study could be used in the development of educational programs to be incorporated into the school curriculum and for the future of helmet safety promotion in the community. In any case, this study has major implications for the future of helmet safety, and its implementation could impact the community in a way that has yet to be unveiled.

References

Adams, E. J., Goodman, A., Sahlqvist, S., Bull, F. C., Ogilvie, D., & iConnect consortium. (2013). Perceptions of the Environment in the Neighborhood Scale [Measurement Instrument]. Retrieved from PsycTESTS. doi: http://dx.doi.org/10.1037/t25189-000

Ajzen, I. (1985). From intentions to actions: A theory of planned behaviour. In *Action control* (pp. 11-39). Springer Berlin Heidelberg.

The American Association of Neurological Surgeons. (2014, August). Sports-related head injury. Retrieved from http://www.aans.org/Patient Information/Conditions and Treatments/Sports-Related Head Injury.aspx

Arnold, L., & Quine, L. (1994). Predicting helmet use among schoolboy cyclists: an application of the Health Belief Model. *Social Psychology and Health: European Perspectives. Brookfield, VT: Avebury/Ashgate Publishing*, 101-130.

Barnes, V. A., Maria, B. L., Caldwell, A. L., & Hopkins, I. (2012). Prevention of Traumatic Brain Injury in Youth and Adolescents. *Journal of Child Neurology, 28*(11), 1412-1417. doi:10.1177/0883073812464272.

Beck, K. H., & Watters, S. (2016). Perceived Risk of Traffic Situations Scale [Measurement Instrument]. Retrieved from PsycTESTS. doi: http://dx.doi.org/10.1037/t59518-000

Berg, P., & Westerling, R. (2001). Bicycle helmet use among schoolchildren—the influence of parental involvement and children's attitudes. *Injury Prevention*, *7*(3), 218-222.

Black, J. E., & Reynolds, W. M. (2016). Development, reliability, and validity of the moral identity questionnaire. *Personality and Individual Differences*, *97*, 120-129.

Boateng, F. D. (2016). Fear of Crime Scale [measurement instrument]. Retrieved from PsycTESTS. doi: http://dx.doi.org/10.1037/t60413-000

Burt, C. W., & Overpeck, M. D. (2001). Emergency visits for sports-related injuries. *Annals of emergency medicine*, *37*(3), 301-308.

Canadian Paediatric Society. (2017). Bicycle helmet legislation. Retrieved from https://www.cps.ca/en/status-report/bicycle-helmet-legislation

Carpenter, C. S., & Warman, C. (2018). *Do 'All-Age' Bicycle Helmet Laws Work? Evidence from Canada* (No. w24644). National Bureau of Economic Research.

Cialdini, R. B., & Goldstein, N. J. (2004). Social influence: Compliance and conformity. *Annu. Rev. Psychol.*, *55*, 591-621.

Cole, D. A., Nick, E. A., Zelkowitz, R. L., Roeder, K. M., & Spinelli, T. (2017). Social Network Scales [Measurement Instrument]. Retrieved from PsycTESTS. doi: http://dx.doi.org/10.1037/t59817-000

Coronado, V. G., Xu, L., Basavaraju, S. V., McGuire, L. C., Wald, M. M., Faul, M. D., & Hemphill, J. D. (2011). *Surveillance for traumatic brain injury-related deaths: United States, 1997-2007* (p. 32). Atlanta: US Department of Health and Human Services, Centers for Disease Control and Prevention.

Coté, T. R., Sacks, J. J., Kresnow, M. J., Lambert-Huber, D. A., Schmidt, E. R., Dannenberg, A. L., & Lipsitz, C. M. (1992). Bicycle helmet use among Maryland children: effect of legislation and education. *Pediatrics*, *89*(6), 1216-1220.

Craik, F. I., & Lockhart, R. S. (1972). Levels of processing: A framework for memory research. *Journal of verbal learning and verbal behaviour*, *11*(6), 671-684.

Craik, F. I., & Tulving, E. (1975). Depth of processing and the retention of words in episodic memory. *Journal of experimental Psychology: general*, *104*(3), 268.

de Wit, B., & Kinoshita, S. (2015). The masked semantic priming effect is task dependent: Reconsidering the automatic spreading activation process. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, *41*(4), 1062.

Finch, C. F. (1996). Teenagers' attitudes towards bicycle helmets three years after the introduction of mandatory wearing. *Injury Prevention*, *2*(2), 126-130.

Finnoff, J. T., Laskowski, E. R., Altman, K. L., & Diehl, N. N. (2001). Barriers to Bicycle Helmet Use. *Pediatrics, 108*(1). doi:10.1542/peds.108.1.e4.

Fishbein, M., & Ajzen, I. (1975). *Belief, attitude, intention and behaviour: An introduction to theory and research*.

Gamble, T., & Walker, I. (2016). Wearing a bicycle helmet can increase risk taking and sensation seeking in adults. *Psychological science*, *27*(2), 289-294.

Goldenbeld, C., Boele, M. J., & Commandeur, J. J. F. (2016). *Evaluation of the bicycle helmet campaign:"Wanna look cool, wear a helmet"' in New Zealand: Effects on helmet use* (Vol. 2016, No. 8).

Government of Ontario, Ministry of Transportation. (2016, September 29). Bicycle Safety. Retrieved from http://www.mto.gov.on.ca/english/safety/bicycle-safety.shtml.

Hirshman, E. (2001). Elaboration in memory.

Hooper, C., & Spicer, J. (2012). Liberty or death; don't tread on me. *Journal of medical ethics*, medethics-2011.

Huybers, S., Fenerty, L., Kureshi, N., Thibault-Halman, G., LeBlanc, J. C., Clarke, D. B., & Walling, S. (2017). Long-term effects of education and legislation enforcement on all-age bicycle helmet use: a longitudinal study. *Journal of community health*, *42*(1), 83-89.

Janssen, I. (2014). Crime and perceptions of safety in the home neighborhood are independently associated with physical activity among 11–15year olds. *Preventive Medicine, 66*, 113-117. doi:10.1016/j.ypmed.2014.06.016

Kelly, K. D., Lissel, H. L., Rowe, B. H., Vincenten, J. A., & Voaklander, D. C. (2001). Sport and recreation-related head injuries treated in the emergency department. *Clinical Journal of Sport Medicine*, *11*(2), 77-81.

Klein, S. B., & Kihlstrom, J. F. (1986). Elaboration, organization, and the self-reference effect in memory. *Journal of Experimental Psychology: General*, *115*(1), 26.

Lajunen, T., & Räsänen, M. (2004). Can social psychological models be used to promote bicycle helmet use among teenagers? A comparison of the Health Belief Model, Theory of Planned Behaviour and the Locus of Control. *Journal of safety research*, *35*(1), 115-123.

LeBlanc, J. C., Beattie, T. L., & Culligan, C. (2002). Effect of legislation on the use of bicycle helmets. *Canadian Medical Association Journal*, *166*(5), 592-595.

Macpherson, A., & Spinks, A. (2008). Cochrane review: Bicycle helmet legislation for the uptake of helmet use and prevention of head injuries. *Evidence‐Based Child Health: A Cochrane Review Journal*, *3*(1), 16-32.

Maimaris, C., Summer, C. L., Browning, C., & Palmer, C. R. (1994). Injury patterns in cyclists attending an accident and emergency department: a comparison of helmet wearers and non-wearers. *Bmj*, *308*(6943), 1537-1540. doi:10.1136/bmj.308.6943.1537.

Miller, P. A., Binns, H. J., & Christoffel, K. K. (1996). Children's bicycle helmet attitudes and use: association with parental rules. *Archives of pediatrics & adolescent medicine*, *150*(12), 1259-1264.

Mlinarevic, D. (2017). Use Your Head: An Assessment of the Willingness to Wear a Helmet in Adolescents. *Unpublished.*

Moore, D. W., & Adair, V. (1990). Effects of a School-based Education Programme on Safety Helmet Usage by 11-to 13-year-old Cyclists. *Educational Psychology*, *10*(1), 73-78.

Morrongiello, B. A., Cusimano, M., Barton, B. K., Orr, E., Chipman, M., Tyberg, J., … Bekele, T. (2010) BACKIE questionnaire: A measure of children's behaviours, attitudes, cognitions, knowledge and injury experiences.

Norman, G. (2010). Likert scales, levels of measurement and the "laws" of statistics. *Advances in health sciences education*, *15*(5), 625-632.

Peachey, A. A., Sutton, D. L., & Cathorall, M. L. (2016). Helmet ownership and use among skateboarders: Utilisation of the Health Belief Model. *Health Education Journal*, *75*(5), 565-576.

Pendergrast, R. A., Ashworth, C. S., DuRant, R. H., & Litaker, M. (1993). Correlates of children's bicycle helmet use and short-term failure of school-level interventions. *Journal of Safety Research, 24*(2), 123-124. doi:10.1016/0022-4375(93)90008-B

Povey, L. J., Frith, W. J., & Graham, P. G. (1999). Cycle helmet effectiveness in New Zealand. *Accident Analysis & Prevention*, *31*(6), 763-770.

Quine, L., Rutter, D. R., & Arnold, L. (2001). Persuading school-age cyclists to use safety helmets: Effectiveness of an intervention based on the Theory of Planned Behaviour. *British Journal of Health Psychology*, *6*(4), 327-345.

Quine, L., Rutter, D. R., & Arnold, L. (1998). Predicting and understanding safety helmet use among schoolboy cyclists: a comparison of the theory of planned behaviour and the health belief model. *Psychology and Health*, *13*(2), 251-269.

Rodgers, G. B. (2002). Effects of state helmet laws on bicycle helmet use by children and adolescents. *Injury Prevention*, *8*(1), 42-46.

Rosenstock, I. M. (1974). Historical origins of the health belief model. *Health education monographs*, *2*(4), 328-335.

Ross, T. P., Ross, L. T., Rahman, A., & Cataldo, S. (2010). The bicycle helmet attitudes scale: using the health belief model to predict helmet use among undergraduates. *Journal of American College Health*, *59*(1), 29-36.

Secginli, S., Cosansu, G., & Nahcivan, N. O. (2014). Factors associated with bicycle-helmet use among 8–16 years aged Turkish children: a questionnaire survey. *International journal of injury control and safety promotion*, *21*(4), 367-375.

Statistics Canada (2016). Helmet use in recreational activities, 2013-2014. Retrieved from http://www.statcan.gc.ca/pub/82-625-x/2016001/article/14628-eng.htm

Thomas, S., Acton, C., Nixon, J., Battistutta, D., Pitt, W. R., & Clark, R. (1994). Effectiveness of bicycle helmets in preventing head injury in children: case-control study. *Bmj*, *308*(6922), 173-176.

Towner, P., & Marvel, M. K. (1992). A school-based intervention to increase the use of bicycle helmets. *Family medicine*, *24*(2), 156-158.

Wege, N., Li, J., Muth, T., Angerer, P., & Siegrist, J. (2017). Effort-Reward Imbalance Questionnaire--Short Version for University Students [Measurement Instrument]. Retrieved from PsycTESTS. doi: http://dx.doi.org/10.1037/t60694-000

Witte, K., Stokols, D., Ituarte, P., & Schneider, M. (1993). Testing the health belief model in a field study to promote bicycle safety helmets. *Communication Research*, *20*(4), 564-586.

Appendix A

Questionnaires Given to Participants

STUDENT LIFE QUESTIONNAIRE

On the following questions, please indicate whether you agree or disagree with the statements, with 1 being "strongly disagree" and 5 being "strongly agree".

	Strongly Disagree	Somewhat Disagree	Neutral	Somewhat Agree	Strongly Agree
In my neighbourhood, it is safe for children to play outside during the day	1	2	3	4	5
I always wear a helmet when I ride my bike	1	2	3	4	5
I could ask for help or a favour from neighbours	1	2	3	4	5
People in my neighbourhood say hello and talk to each other in the street	1	2	3	4	5
Everyone in a vehicle should wear a seatbelt	1	2	3	4	5
When I cross the street, I look both left and right. If there are no cars, I can cross the road safely.	1	2	3	4	5
I don't think I will be badly hurt if I fall off my bike	1	2	3	4	5
If someone is a good driver, it is okay if they drive a little faster	1	2	3	4	5
As you get older, you do not have to worry so much about wearing a bike helmet when you ride your bike	1	2	3	4	5
There are no convenient routes for walking and cycling in my area	1	2	3	4	5
My area is generally free from litter or graffiti	1	2	3	4	5
There are places to walk or cycle to (ex. Shops, restaurants, leisure facilities)	1	2	3	4	5
There are open spaces (ex. Parks, sports fields, beaches)	1	2	3	4	5
There are special lanes, routes or paths for cycling	1	2	3	4	5
My area is pleasant for walking or cycling	1	2	3	4	5

I always ride my bike with traffic (not facing it)	1	2	3	4	5
I always walk facing traffic if there are no sidewalks	1	2	3	4	5
I have constant time pressure due to a heavy study load at school	1	2	3	4	5
I have many interruptions and disturbances while preparing for my exams	1	2	3	4	5
My study load has become more and more demanding	1	2	3	4	5
I receive the respect I deserve from my teachers	1	2	3	4	5
I receive the respect I deserve from my fellow students	1	2	3	4	5
Considering all my efforts, I receive the appreciation that I deserve	1	2	3	4	5
As soon as I get up in the morning I start thinking about study problems	1	2	3	4	5
When I get home, I can easily relax and “switch off” from studying	1	2	3	4	5
Student work rarely lets me go; it is still on my mind when I go to bed	1	2	3	4	5
If I postpone something that was supposed to be done today I’ll have trouble sleeping at night	1	2	3	4	5
I try hard to act honestly in most things I do	1	2	3	4	5
Not hurting other people is one of the rules I live by	1	2	3	4	5
It is important for me to treat other people fairly	1	2	3	4	5
I want other people to know they can rely on me	1	2	3	4	5
I always act in ways that do the most good and least harm to other people	1	2	3	4	5
If doing something will hurt another person, I try to avoid it even if no one would know	1	2	3	4	5

One of the most important things in life is to do what you know is right	1	2	3	4	5
Once I've made up my mind about what is the right thing to do, I make sure I do it	1	2	3	4	5
As long as I make a decision to do something that helps me, it does not matter much if other people are harmed	1	2	3	4	5
It is ok to do something you know is wrong if the rewards for doing it are great	1	2	3	4	5
If no one is watching or will know it does not matter if I do the right thing	1	2	3	4	5
It is more important that people think you are honest than being honest	1	2	3	4	5
If no one could find out, it is okay to steal a small amount of money or other things that no one will miss	1	2	3	4	5
There is no point in going out of my way to do something good if no one is around to appreciate it	1	2	3	4	5
If a cashier accidentally gives me $10 extra change, I usually act as if I didn't notice it	1	2	3	4	5
Doing things that some people might view as not honest does not bother me	1	2	3	4	5
If people treat me badly, I will treat them in the same manner	1	2	3	4	5
I will go along with a group decision, even if I know it is morally wrong	1	2	3	4	5
For the next set of questions, assume 1 to be "very unlikely" and 5 to be "almost certain"	Very unlikely	Somewhat unlikely	Neutral	Somewhat likely	Almost Certain

What do you think the chances are of getting a ticket if you do not wear a seat belt?	1	2	3	4	5
If you drove after having too much to drink, how likely are you to be stopped by a police officer?	1	2	3	4	5
What do you think the chances are of getting a ticket if you drive over the speed limit?	1	2	3	4	5
What do you think the chances are of getting in a car accident if you drive over the speed limit?	1	2	3	4	5
What do you think the chances are of getting in an accident if you use your cell phone to talk to someone while driving?	1	2	3	4	5
What do you think the chances are of getting in an accident if you text someone while driving?	1	2	3	4	5
What do you think the chances are of getting in an accident if you drink and drive?	1	2	3	4	5

Vita Auctoris

Daniella Mlinarevic was born in 1995 in Windsor, Ontario. She graduated from St. Anne's High School in 2013. From there she went on to the University of Windsor where she obtained a B.Sc. in Behaviour, Cognition and Neuroscience with a minor in Biochemistry in 2017. She is currently a candidate for the Master's degree in Biology at the University of Windsor and hopes to graduate in Fall 2018.